

Studying the upper tropospheric ozone enhancements over North America: Analysis with TES observations and FLEXPART

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& the TES team

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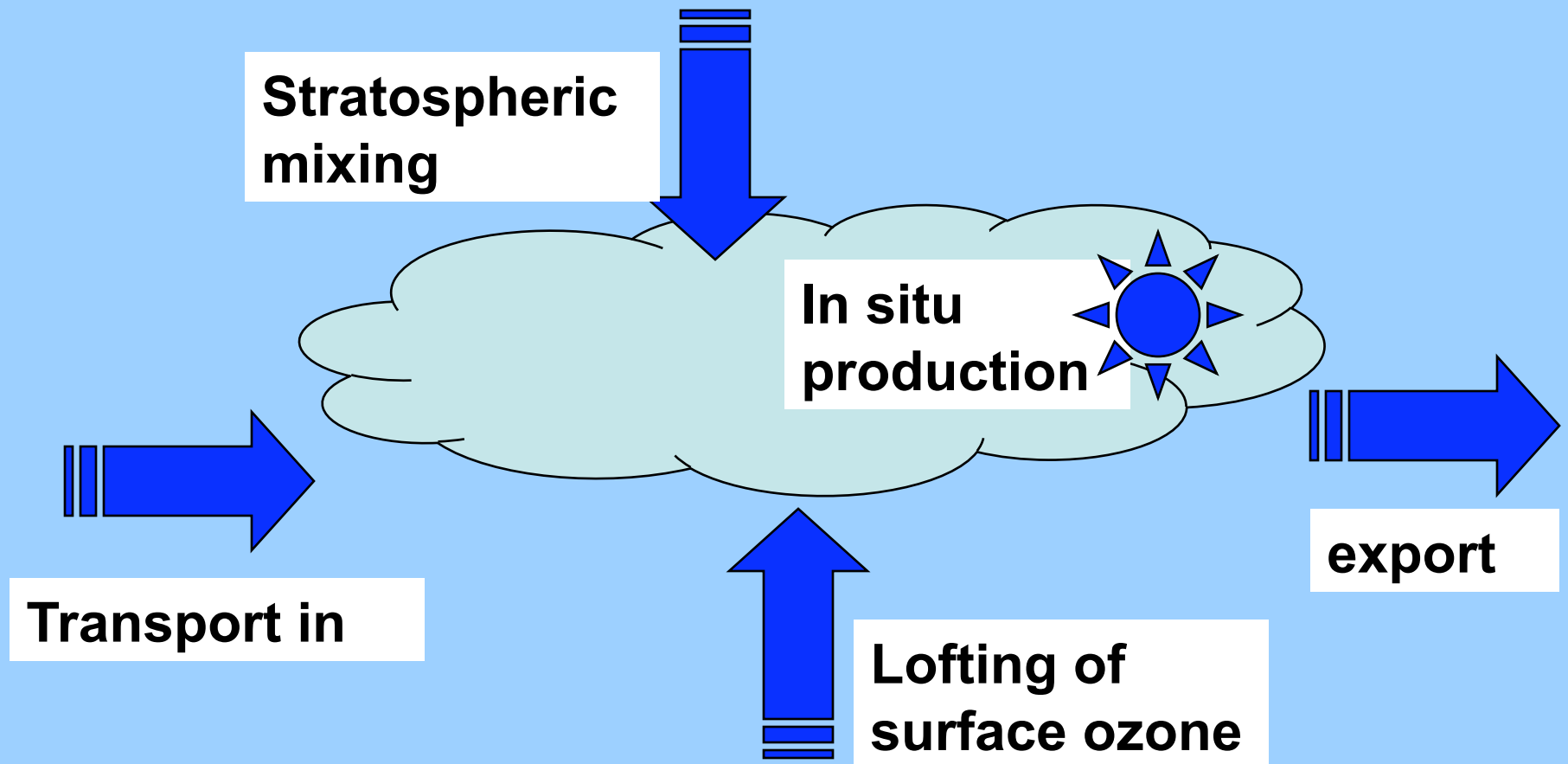
AGU Fall Meeting



Outline

- Motivation
- State of knowledge
- Integration of remote sensing data
- Results
- Future work

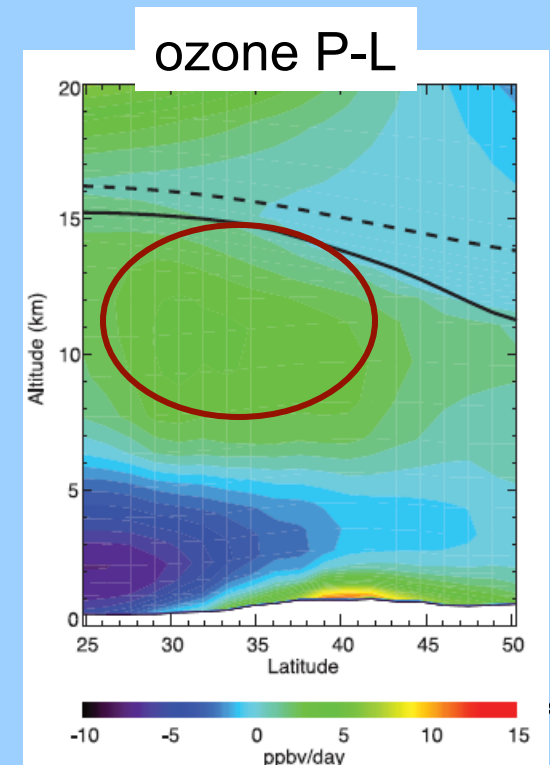
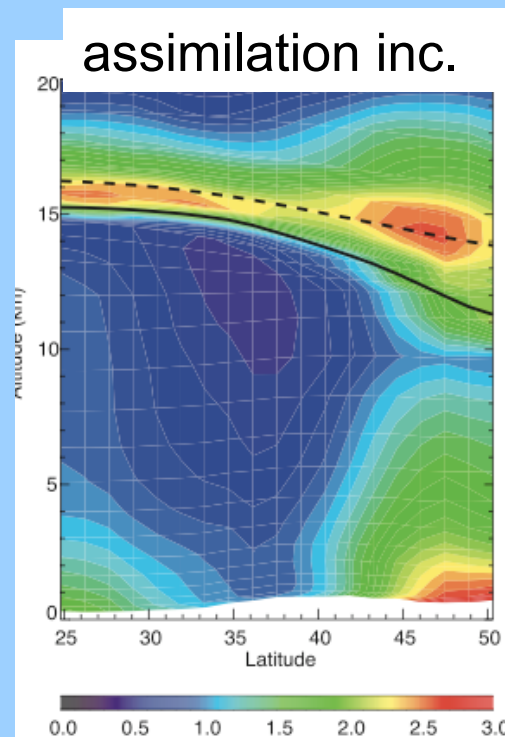
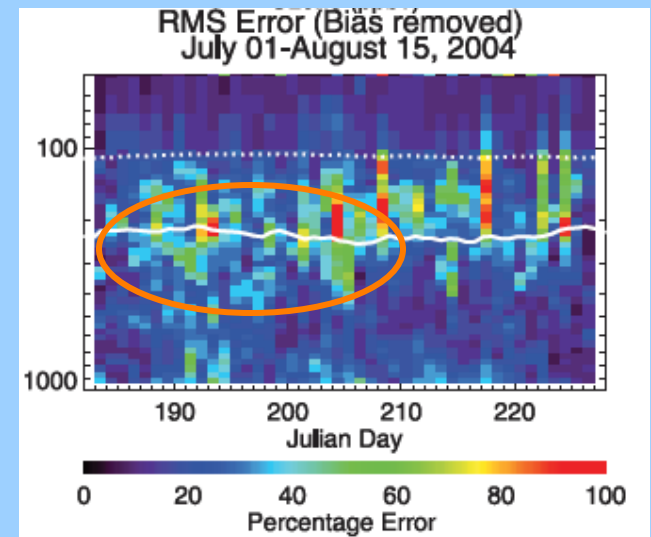
Upper tropospheric ozone budget



New budget estimates from chemical data assimilation

- Pierce et al (2007) using RAQMS model, assimilation solar occultation measurements
- Comparisons to IONS 2004 sondes over US
- Assimilation impact is weak in area of interest

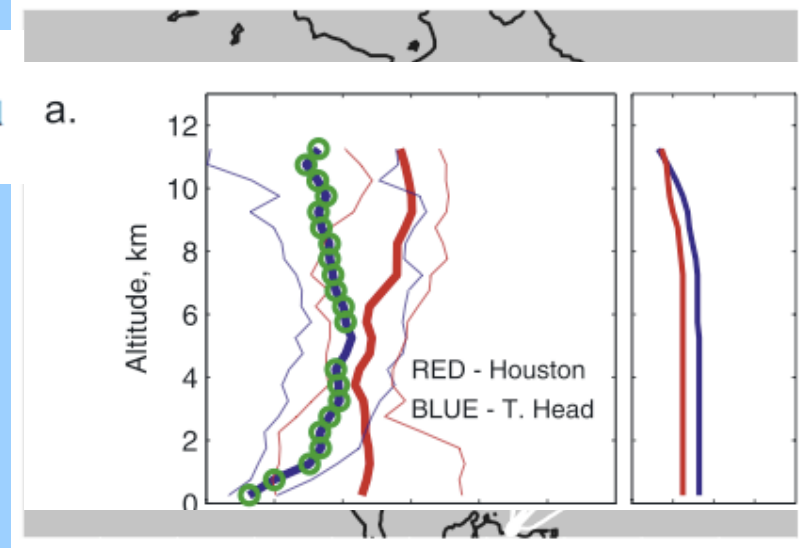
region of interest



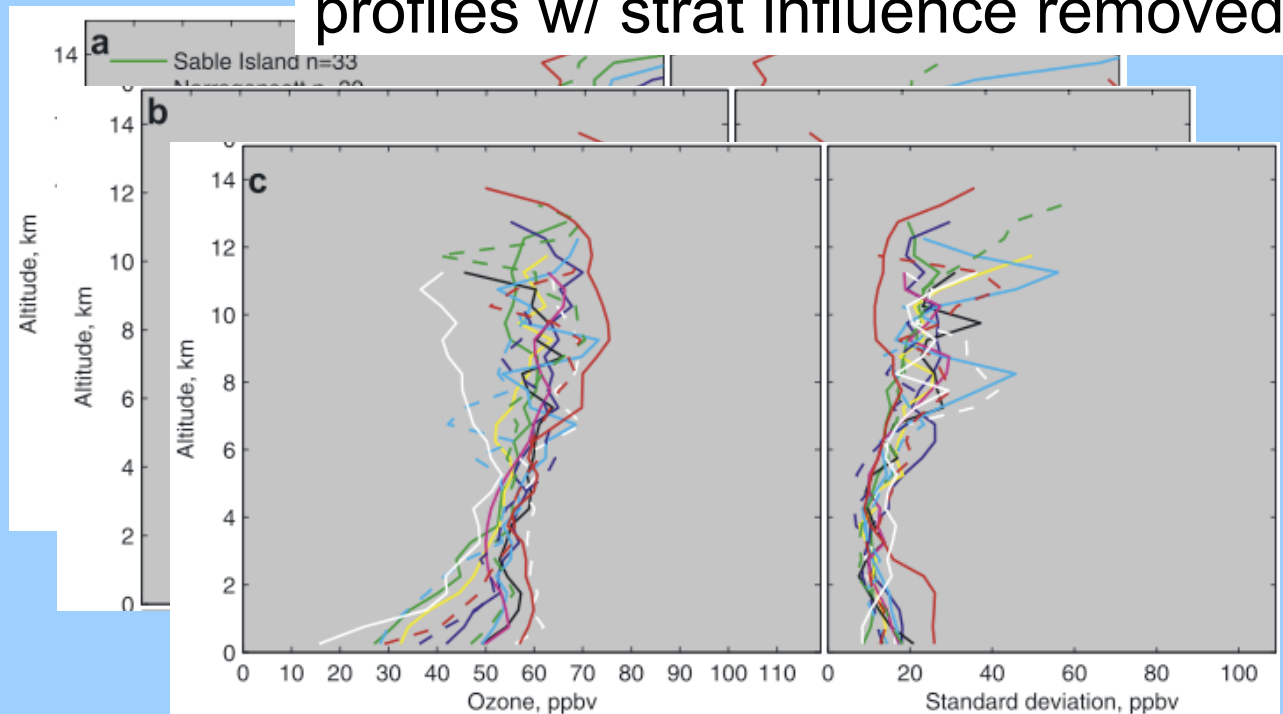
Large upper tropospheric ozone enhancements above midlatitude North America during summer: In situ evidence from the IONS and MOZAIC ozone measurement network

Cooper et al, JGR, 2006

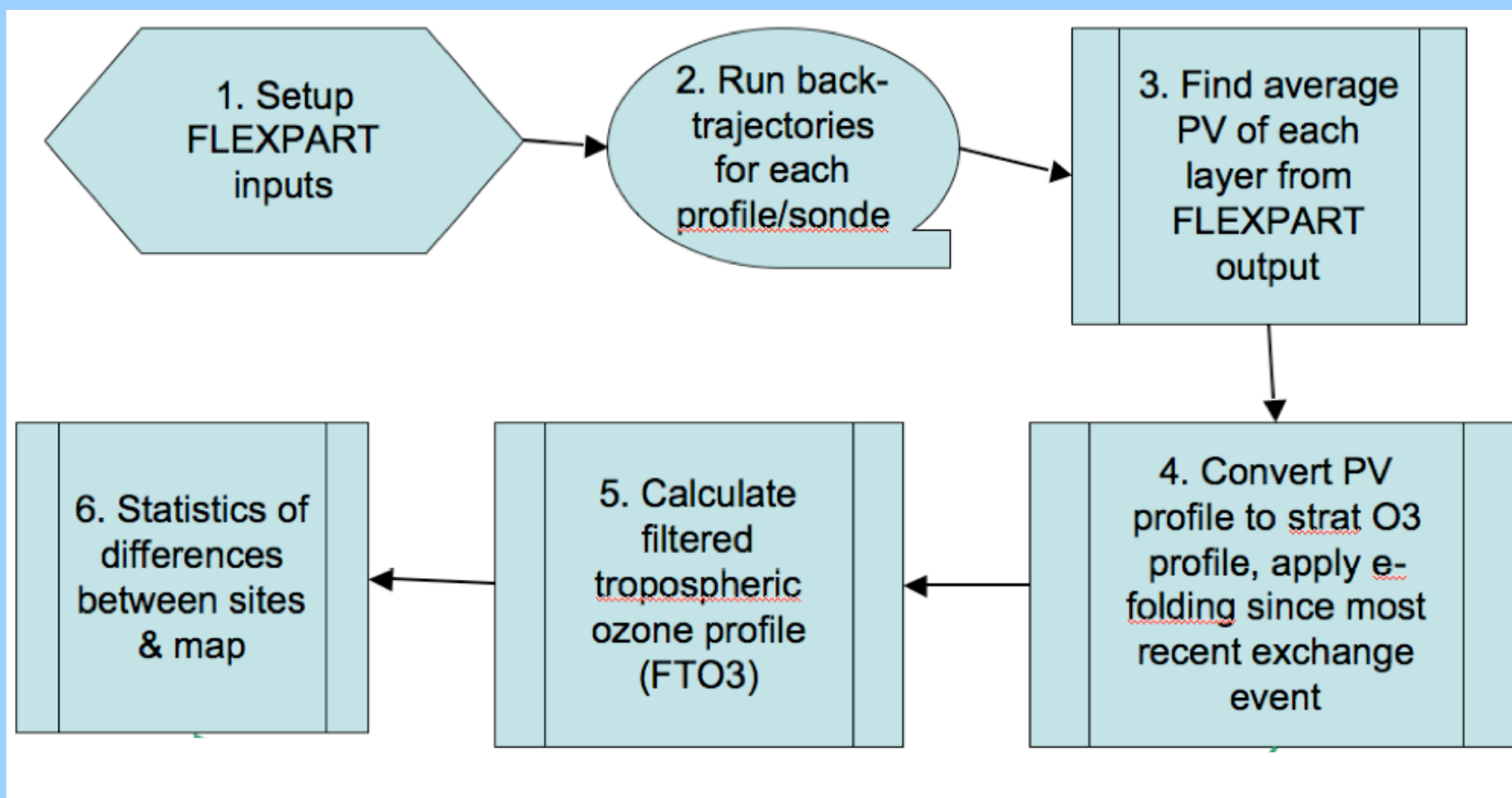
- Sondes provide ozone characterization
- FLEXPART trajectories used to quantify stratospheric influence
- finds 88% of ozone enhancement from in situ production, 69-84% of ozone due to lightning NO_x.



profiles w/ strat influence removed



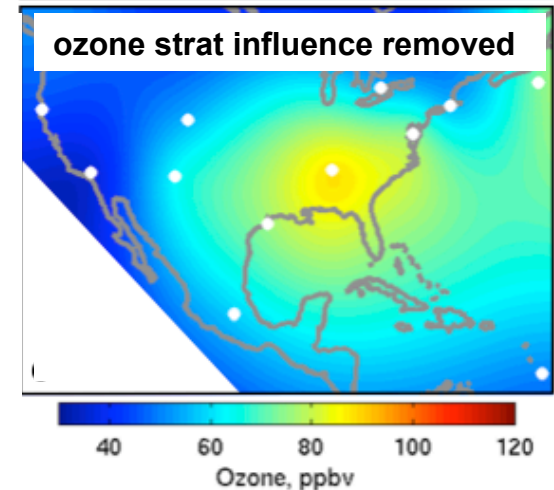
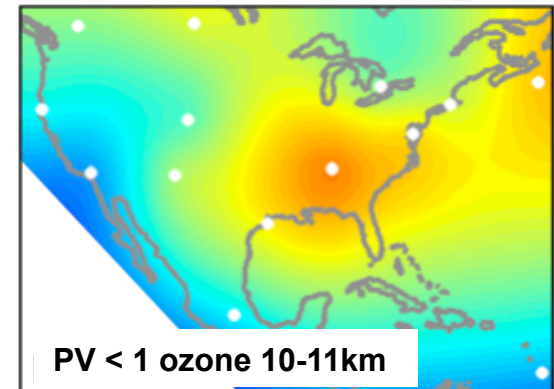
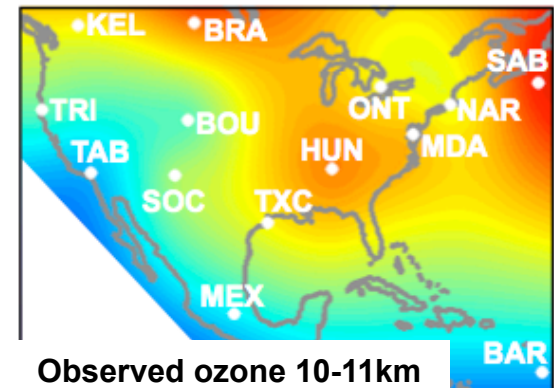
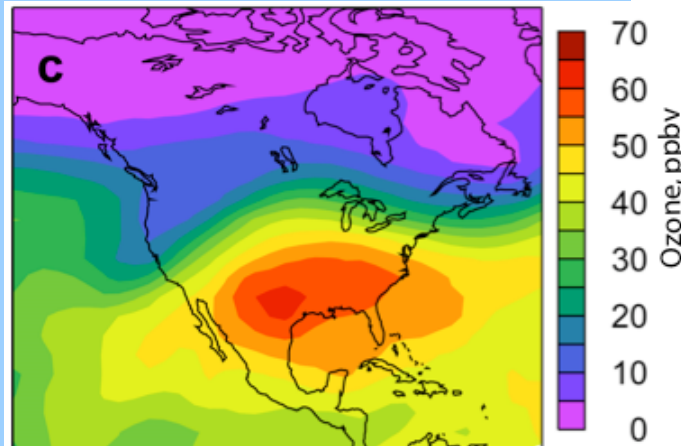
Analysis flow to isolate tropospheric ozone



August 2006 - different location of maximum

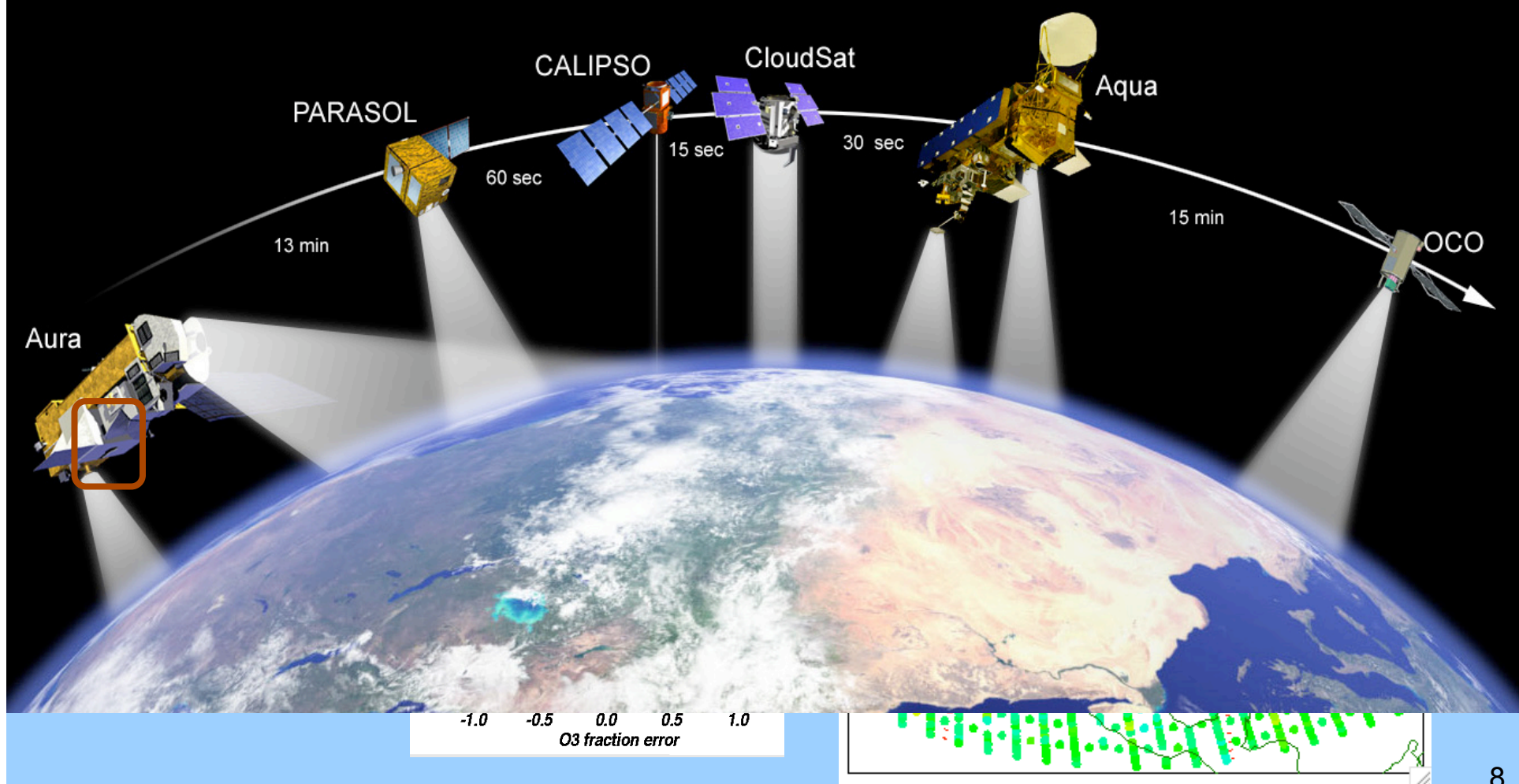
- Cooper et al - As in 2004, ozone mixing ratios in upper trop over Southeast US elevated relative to US west coast
- See more ozone than 2004 and stronger anticyclone driving circulation, and shift of location of maximum from Houston to Huntsville
- 25-30 ppbv ozone from stratosphere
- ECHAM-MESSy model simulations show similar features, but maximum is over Texas.

How can remote sensing measurements add to our understanding?

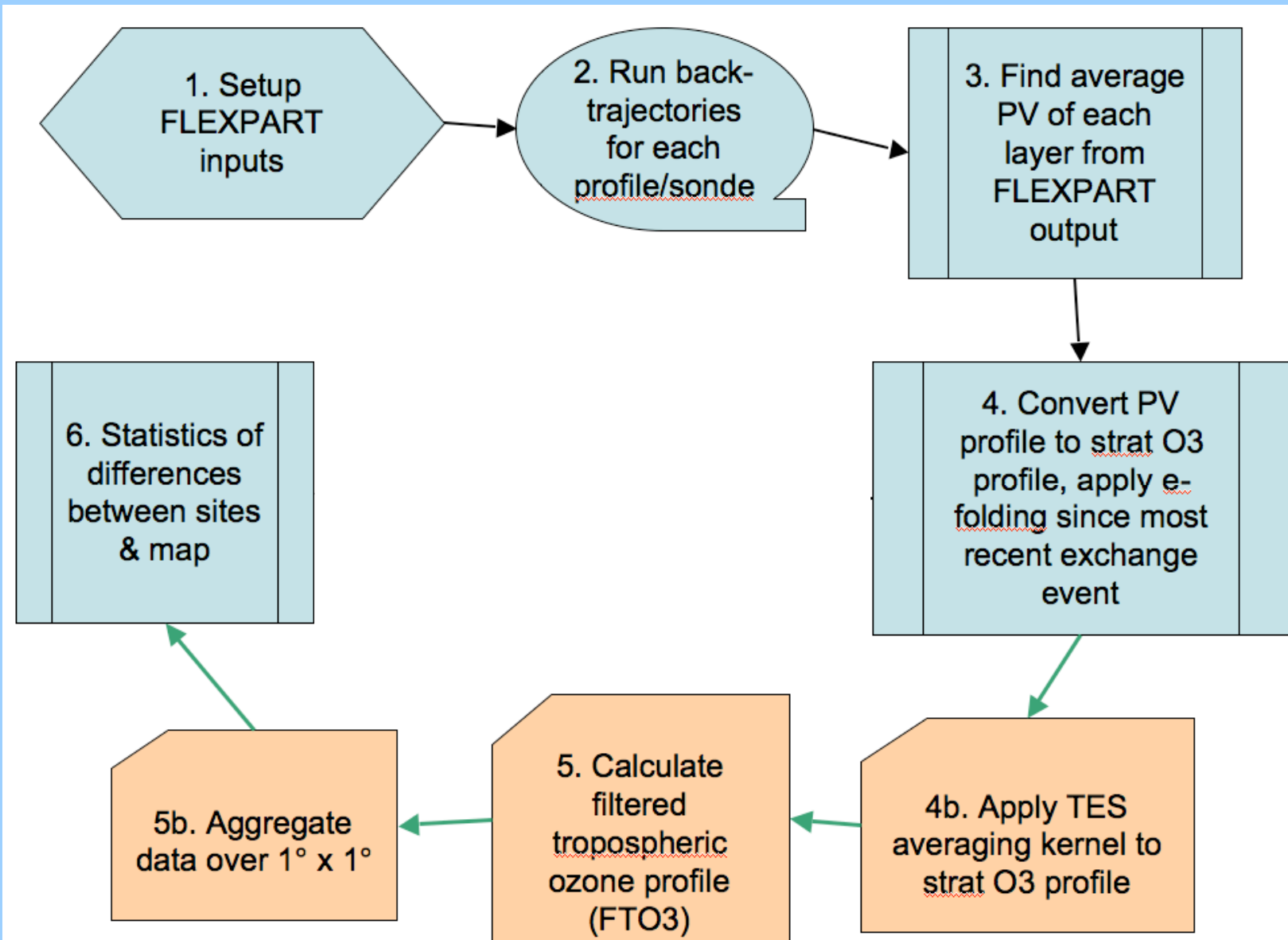


New measurements - TES

The A-Train

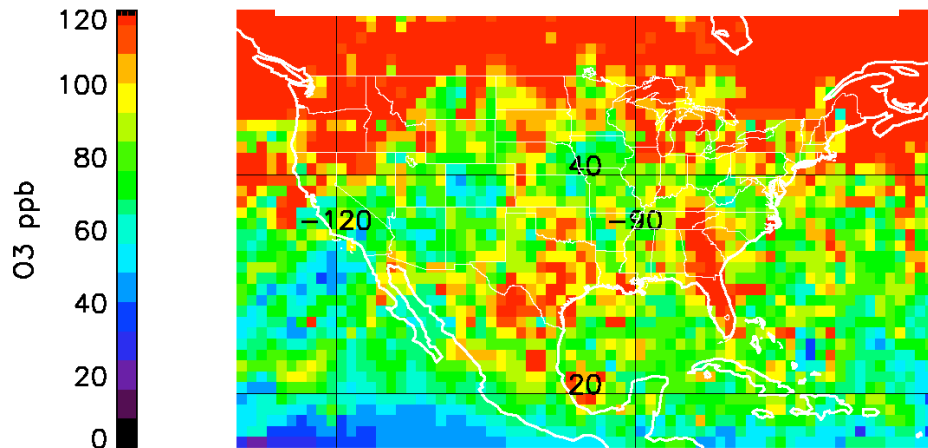


Analysis flow utilizing TES

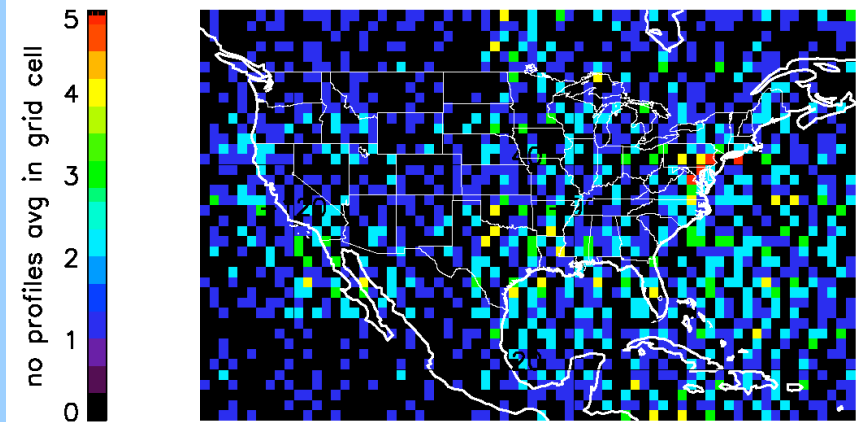


Results for Aug. 2006 @261hPa

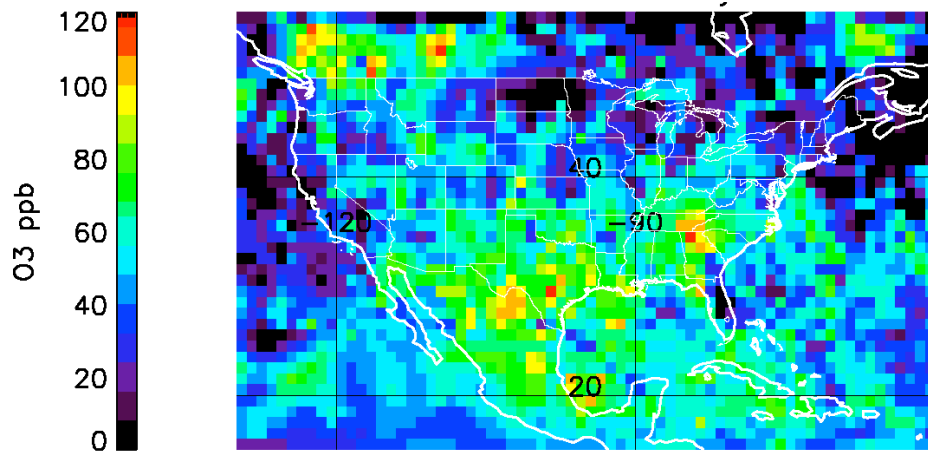
Ozone field from TES



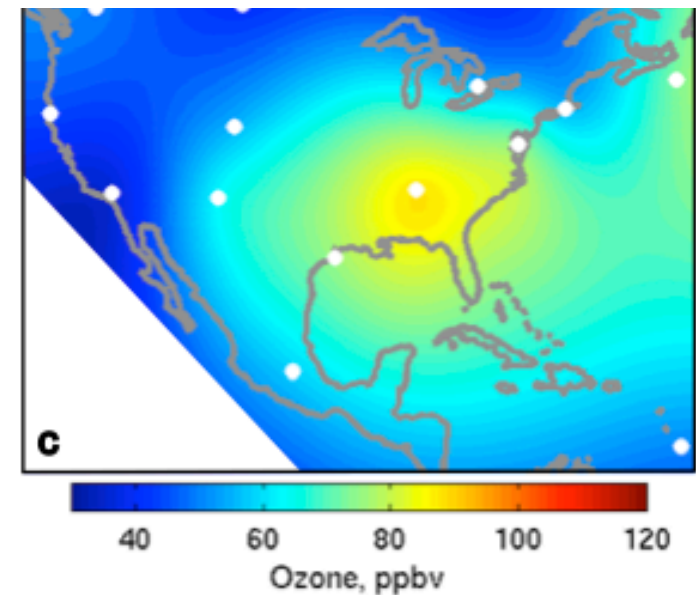
Data used in map



Filtered trop Ozone field from TES -



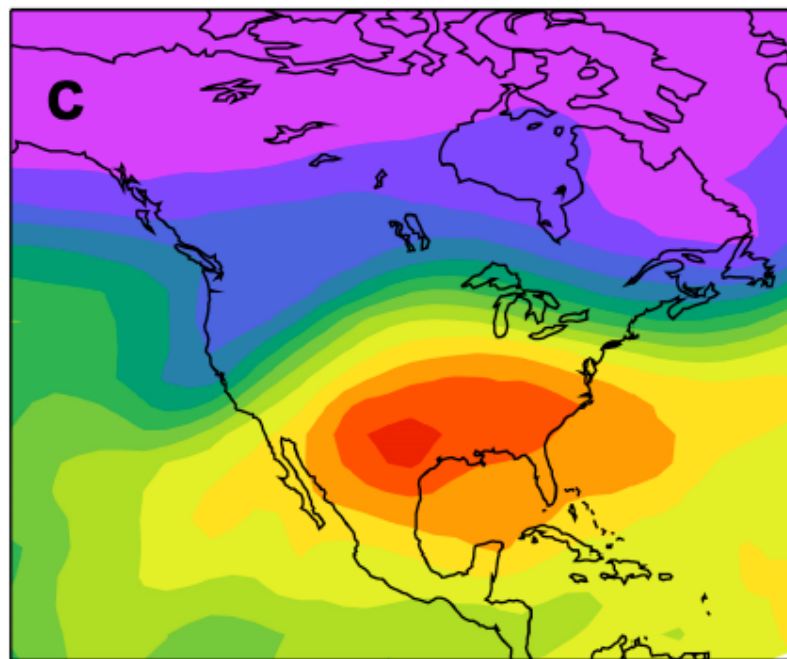
Cooper's results (10-11km)



TES based results match Cooper and MESSy

- Overall,
results

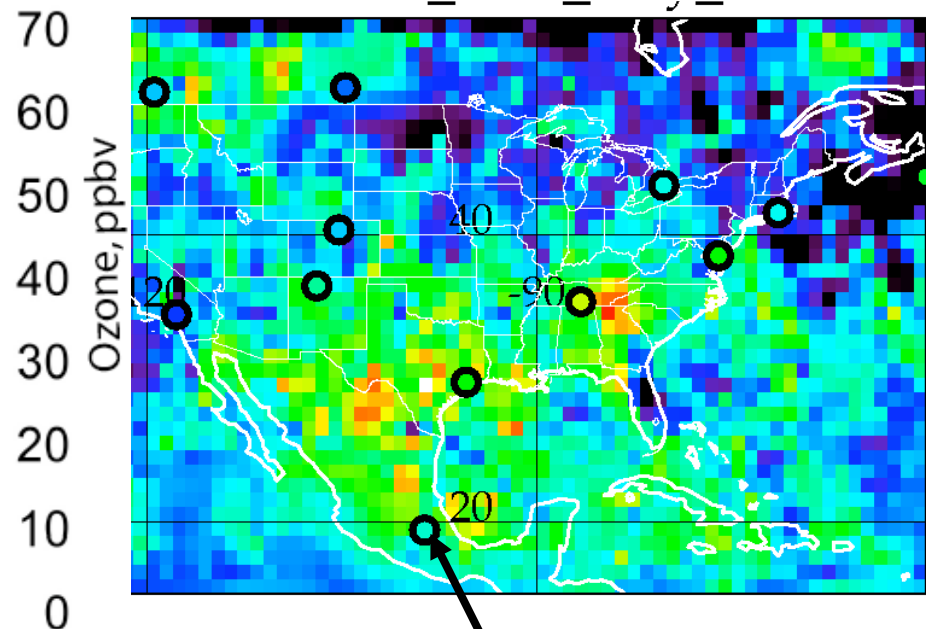
ECHAM MESSy sim - 250hPa



Maximum

over US/
mexico

TES field (287 hPa) with Cooper results

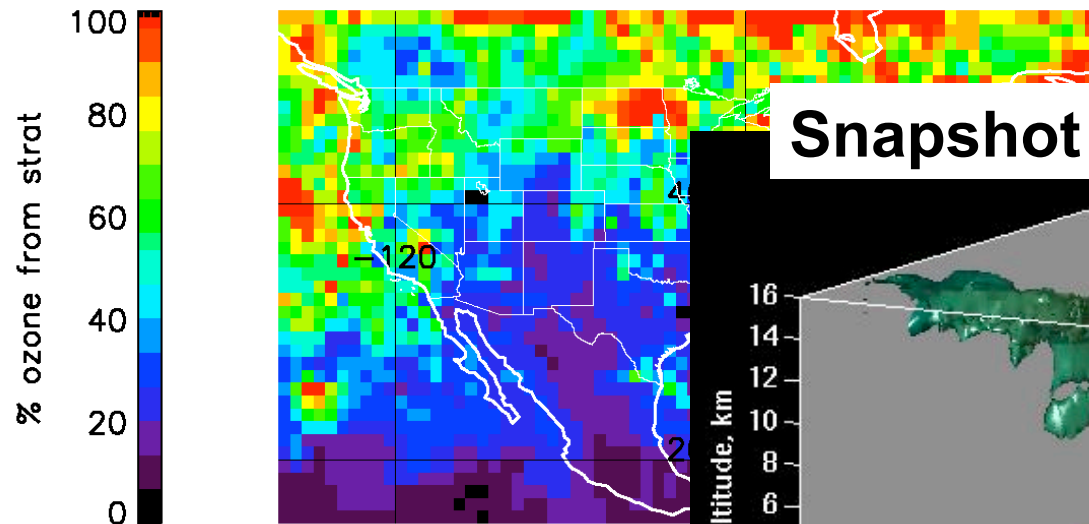


Overlay of sonde
based results

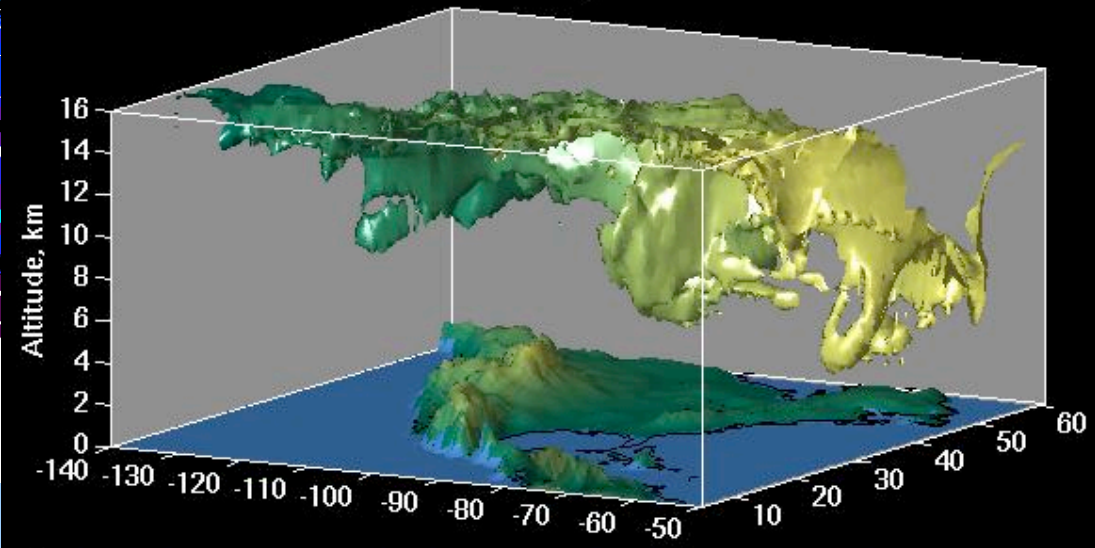
Stratospheric influence

- Typically 15-25%, consistent with other approaches
- Interesting event over Florida

Fraction of Strat O3 @261hPa

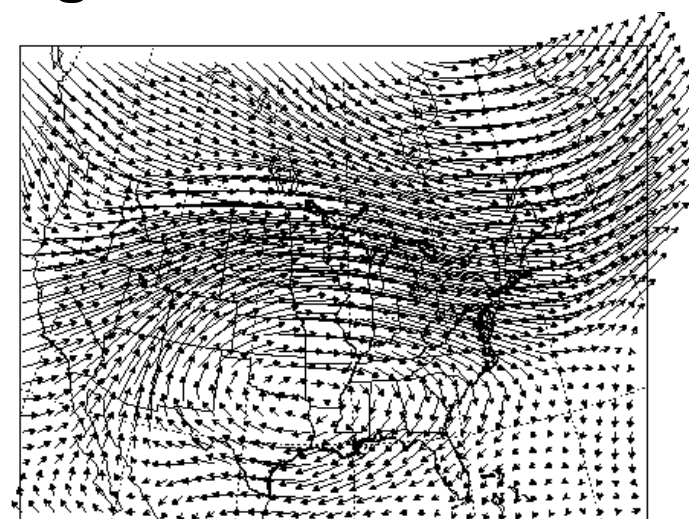


Snapshot of 50 ppb isosurface

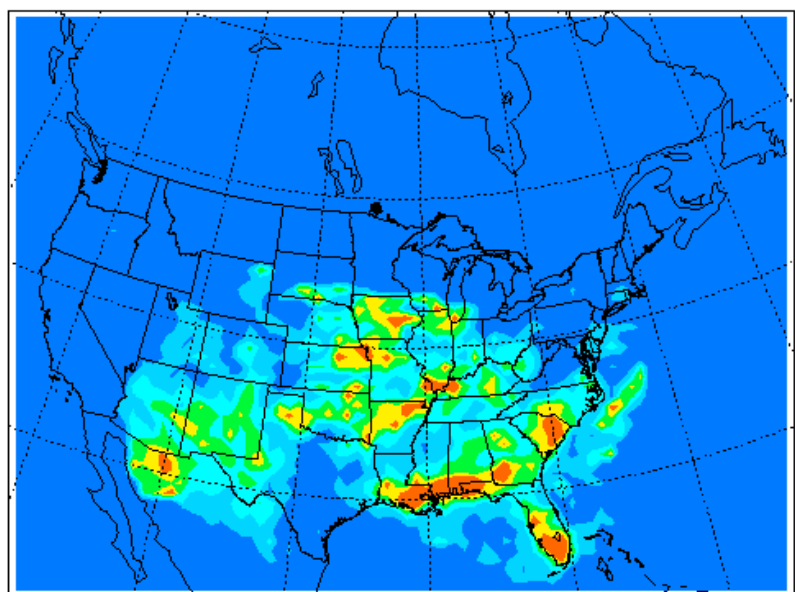


Lightning NOx influence matches ozone max

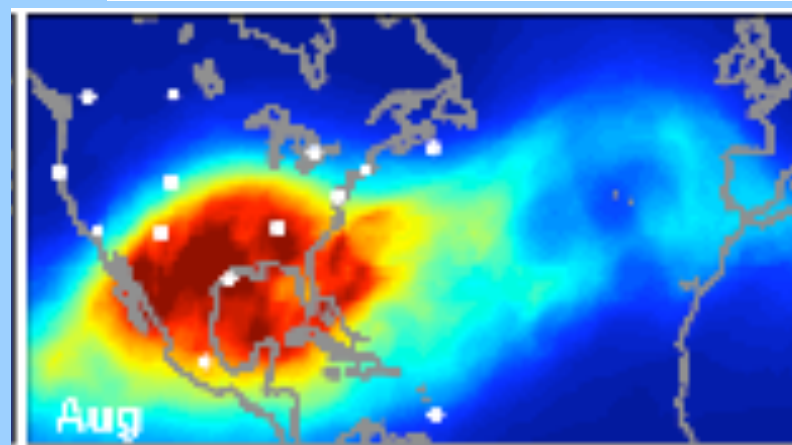
Aug 14-20, 2006 windfields



Aug 2006 NLDN flash density



0.0 0.5 1.0 1.5 2.0 2.5 **flashes/km²/month**



20 day Lightning Nox tracer

Conclusions & next steps

- Upper tropospheric ozone budget is maturing
 - similar estimates from sondes, models, remote sensing for August 2006
- Based on TES, UT ozone max in August 2006 located over Texas-Mexico border, consistent with ECHAM-MESSy model
- With TES data we can quantify and study seasonal and interannual behavior
- Yunsoo Choi is using REAM 3-D regional CTM to understand more of the details

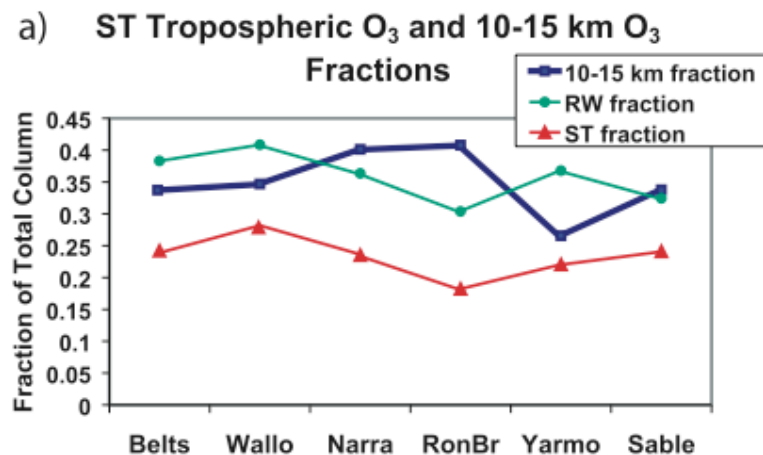
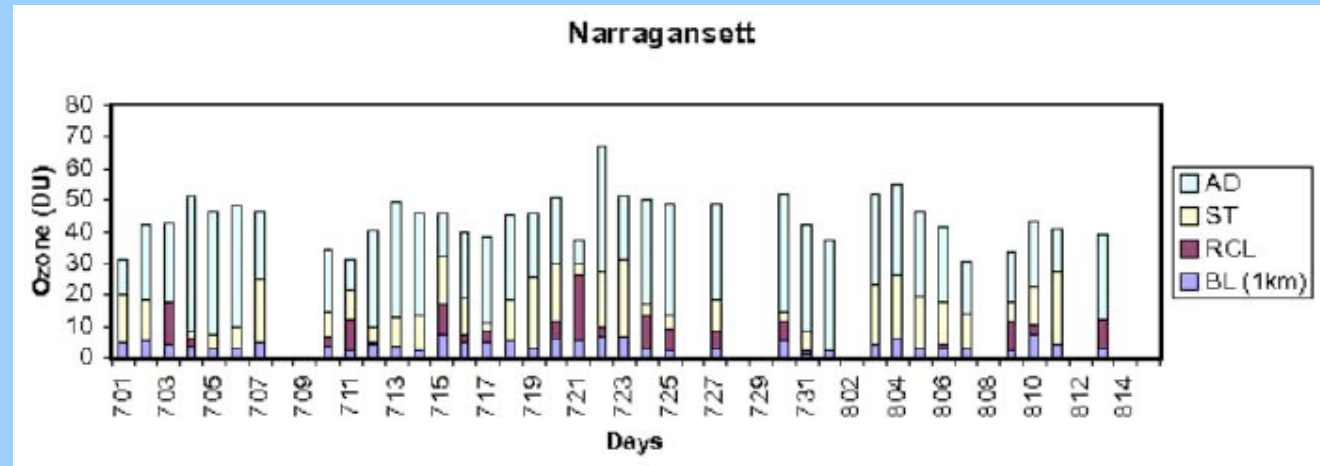
THANK YOU

state of knowledge

- Variety of tool being used to build budget estimates
- Numerous estimates of the contribution of the stratosphere to ozone at 10km
- Some hints at contribution of surface ozone to 10km
- Beginning to have estimates of export and import terms in the budget

Different way of looking at sondes

- Based on IONS 2004 sondes, finds 23% of free trop ozone is from stratosphere



- Finds 10-15% from regional pollution and lightning, 50% mixture of freshly advected pollution and aged background air

Need to add

- Lightning flash counts maps
- Calculate the percent of ozone from the strat
- CO maps